Taxonomic Considerations of the Lantern Fish *Polyipnus spinosus* Günther and Related Species

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THE THREE SPECIES treated in this paper (*Polyipnus spinosus* Günther, *P. stereope* Jordan and Starks, and *P. trigentifer* McCulloch) are rather rare lantern fishes belonging to the family Sternoptychidae. *P. spinosus* (Fig. 1) is a deep sea species known to occur off the Philippines, Borneo, in the Gulf of Guinea, off Cape Morgan, Natal coast, in the Andaman Sea, Suruga Bay, and Kumano-Nada, Japan. *P. stereope* has been taken in Sagami Bay, Suruga Bay, and Kumano-Nada, Japan. *P. trigentifer* is known only from the Great Australian Bight. Several ichthyologists have presented opinions on the relationship of these species but their validity has remained in doubt.

In 1887 Günther described *Polyipnus spinosus* from a specimen obtained from the deep sea between the Philippines and Borneo. Subsequently Alcock (1889), Wood-Mason and Alcock (1891), Goode and Bean (1895), Brauer (1906), Weber and de Beaufort (1913), Barnard (1925), Fowler (1936), Parr (1937), Schultz (1938), and Matsubara (1941, 1950) have also described this species. In 1904 Jordan and Starks described *Polyipnus stereope* based on a specimen collected by the U.S. Fish Commission Steamer "Albatross" from Sagami Bay, and remarked that this species differs from *Polyipnus spinosus* Günther in the character of the posttemporal process. In 1914 McCulloch described *Polyipnus trigentifer* as a new species based on many specimens collected from the Great Australian Bight. At the end of his description of *Polyipnus trigentifer* he noted that this species is very near to *Polyipnus spinosus* Günther and *Polyipnus stereope* Jordan and Starks but has more dorsal and anal rays, a greater number of anal photophores, and a much greater development of the posttemporal process.

The amalgamation of these three species into one has been proposed by Schultz and by Matsubara. In 1938, in his review of the fishes of the genera *Polyipnus* and *Argyropelecus* (Family Sternoptychidae), Schultz considered *Polyipnus stereope* Jordan and Starks and *Polyipnus trigentifer* McCulloch to be synonyms of *Polyipnus spinosus* Günther. In 1941, Matsubara described the fishes of the genus *Poly-*

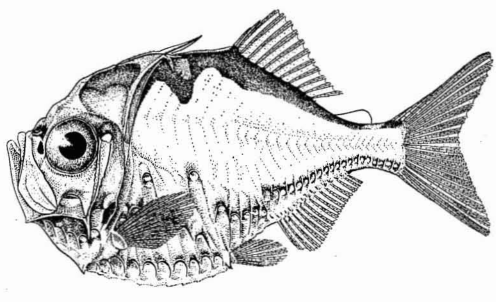

FIG. 1. *Polyipnus spinosus* Günther, natural size. (No. 4810, Kumano-Nada.)

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ipnus found in Suruga Bay and concurred in Schultz's opinion concerning *Polyipnus spinosus* Günther. Furthermore, in 1952, in his examination of the fishes of the genus *Polyipnus* taken from Kumano-Nada, Matsubara treated *Polyipnus stereope* Jordan and Starks and *Polyipnus trigentifer* McCulloch as synonyms of *Polyipnus spinosus* Günther.

Among the fishes obtained off Owashi, Mie Prefecture, in November, 1953, and April, 1954, at a depth of about 200 fathoms, were 130 specimens of the genus *Polyipnus*. Upon careful examination of these specimens and a review of the descriptions given by various authors we came to the conclusion that there exist two distinct forms among these specimens and that 98 are referable to *Polyipnus spinosus* Günther and 32 to *Polyipnus stereope* Jordan and Starks. A distinction between the two is obvious in such body proportional characters as depth at origin of dorsal, depth at the end of dorsal, depth of caudal peduncle, and length of posttemporal process in relation to body length, and in such meristic characters as number of gill rakers on the first gill arch and number of pectoral fin rays. These differences are here considered in detail.

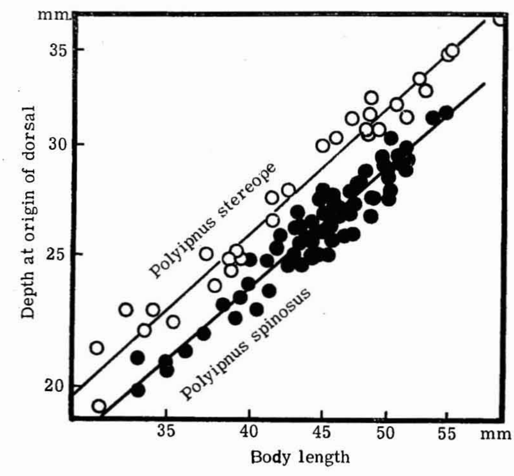

FIG. 2. The allometric lines of depth at origin of dorsal–body length in *Polyipnus spinosus* and *P. stereope*.

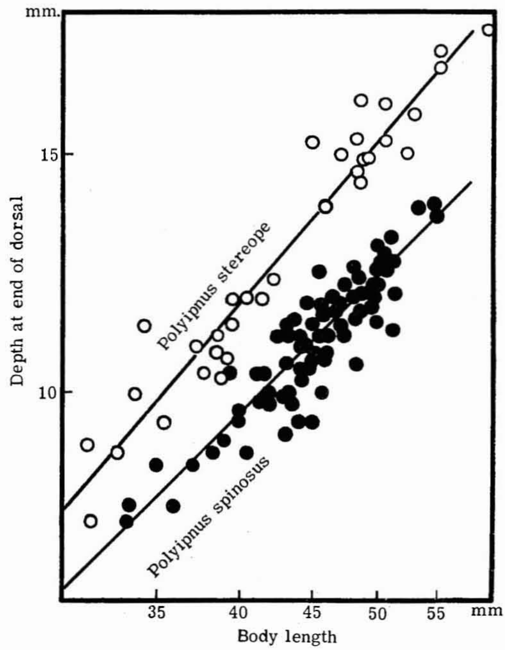

FIG. 3. The allometric lines of depth at end of dorsal–body length in *Polyipnus spinosus* and *P. stereope*.

Body Proportional Characters

Huxley's allometic equation[2] is respectively applied to the four body parts to the body length in order to define the difference of the quantitative morphogenesis of these body parts between *P. spinosus* and *P. stereope*. The growth coefficient and initial growth index in samples of each body part to the body length in two allometric lines are indicated in Table 1.

For the two allometric lines of four body parts to the body length, a test of significancy of "slope differences" and "positional differences" was respectively carried out. The results are:

a. Depth at origin of dorsal–body length relationship (Fig. 2, Table 2). As indicated

[2] The equation is now generally written $y = bx^{\alpha}$, and is termed the single allometric formula. It may be given the form $log\, y = log\, b + \alpha\, log\, x$ ($y = b + \alpha x$), showing that when the logarithms of two dimensions x and y obeying the law are plotted against one another, the points lie along a straight line.

TABLE 1
GROWTH COEFFICIENT ($\hat{\alpha}$) AND INITIAL GROWTH INDEX ($\hat{b}$) IN SAMPLE OF FOUR BODY PARTS TO THE BODY LENGTH

	Polyipnus spinosus		*Polyipnus stereope*	
	$\hat{\alpha}$	$\hat{b}$	$\hat{\alpha}$	$\hat{b}$
(a) Depth at origin of dorsal	0.89682	−0.06331	0.93898	−0.09277
(b) Depth at end of dorsal	1.05345	−0.70645	1.22516	−0.89722
(c) Depth of caudal peduncle	0.72965	−0.52539	0.95444	−0.77841
(d) Length of posttemporal process	0.54217	0.16408	0.55194	0.08096

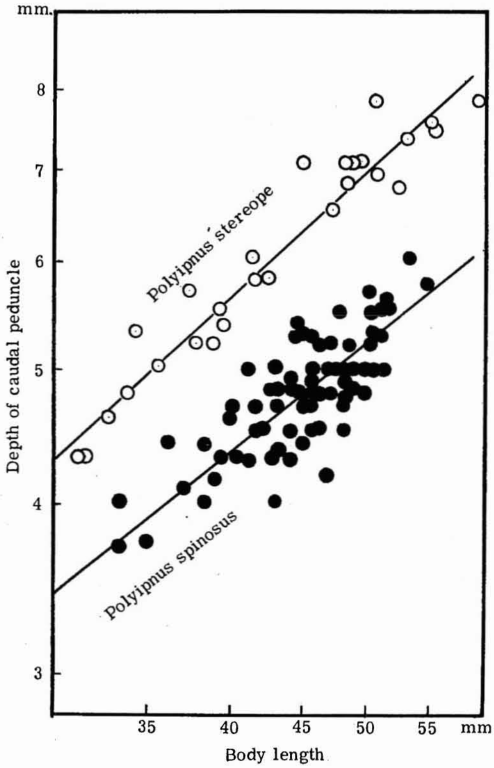

FIG. 4. The allometric lines of depth of caudal peduncle–body length in *Polyipnus spinosus* and *P. stereope*.

in Table 2, there is no significant difference with "slope," but the "positional difference" is obviously significant (level of significance, 1 per cent).

b. Depth at end of dorsal–body length relationship (Fig. 3, Table 3). As indicated in Table 3, the two lines have different "slopes" (level of significance, 5 per cent) and "positions" (level of significance, 1 per cent).
c. Depth of caudal peduncle–body length relationship (Fig. 4, Table 4). As indicated in Table 4, the "slopes" and "positions" representing the two allometry lines are significantly different (level of significance, 1 per cent in each case).
d. Length of posttemporal process–body length relationship (Fig. 5, Table 5). As indicated in Table 5, there is no significant difference with "slope," but the "positional difference" is obviously significant (level of significance, 1 per cent).

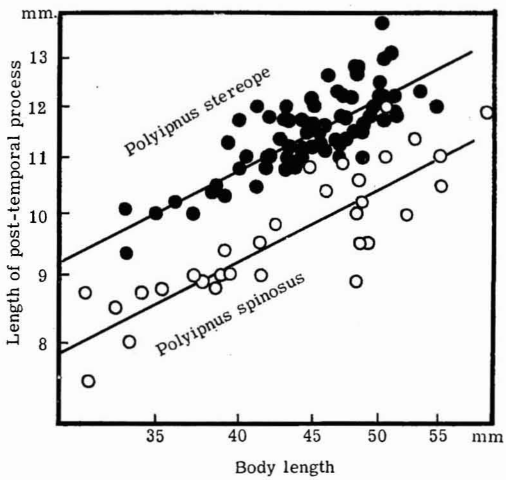

FIG. 5. The allometric lines of length of the post-temporal process–body length in *Polyipnus spinosus* and *P. stereope*.

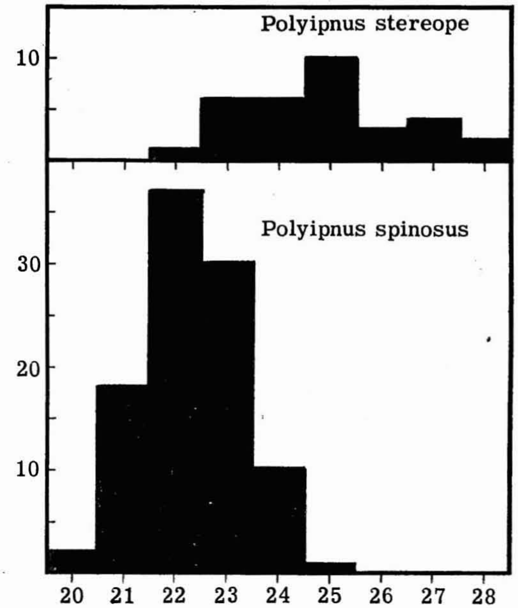

FIG. 6. Frequency of gill rakers on the first gill arch of *Polyipnus spinosus* and *P. stereope*.

The results of these analyses are summarized in Table 6.

Significant "slope differences" in the two allometric lines may be recognized in the depth at end of dorsal to body length and depth of caudal peduncle to body length but not in the depth at origin of dorsal and length of posttemporal process to body length. Furthermore, "positional differences" in the two allometric lines undoubtedly may be expected in these body parts to body length.

Meristic Characters

To indicate the differences of meristic characters between the two species more satisfactorily, we have indicated the frequency distributions of meristic characters by histograms for each species. The two meristic characters used are:

1. Numbers of gill rakers on the first arch (Fig. 6).

In *P. spinosus* the numbers of gill rakers on the first arch are distributed from 20 to 25 and the mode of these frequencies may be recognized at 22. But in *P. stereope* the frequencies are distributed from 22 to 28 and the mode of these frequencies may be recognized at 25.

2. Numbers of pectoral fin rays (Fig. 7).

In *P. spinosus* the numbers of pectoral fin rays are distributed from 12 to 14 and the mode of these frequencies may be recognized at 13. But in *P. stereope* the frequencies are distributed from 13 to 16 and the mode may be recognized at 14.

From these observations we have found that the two species are apparently separable in four body proportional characters and two meristic characters. Therefore we conclude that *Polyipnus stereope* Jordan and Starks should be treated as a distinct species. We are unable to come to a decision as to whether *Polyipnus trigentifer* McCulloch is to be regarded as a synonym of one of these other two species or not, because we were unable to obtain Australian specimens of *Polyipnus trigentifer* McCulloch to compare with the present two species. However *Polyipnus trigentifer* McCulloch seems to differ from both of the present two species in the numbers of anal photophores, that is it has 15–17 whereas the other two species have 12–14.

TABLE 2
"SLOPE AND POSITIONAL DIFFERENCES" BETWEEN TWO ALLOMETRIC LINES OF DEPTH AT ORIGIN OF DORSAL–BODY LENGTH RELATIONSHIP

RESIDUE FORM	SUM OF SQUARES	(d.f.)	(S.S./d.f.)
Separate lines	0.02136	126	0.000170
Slope differences	0.00016	1	0.000160
Parallel lines	0.02125	127	$F_0 = 0.941$
Parallel lines	0.02125	127	0.000169
Positional differences	0.03738	1	0.037380
Single line	0.05890	128	$F_0 = 221.183^{**}$

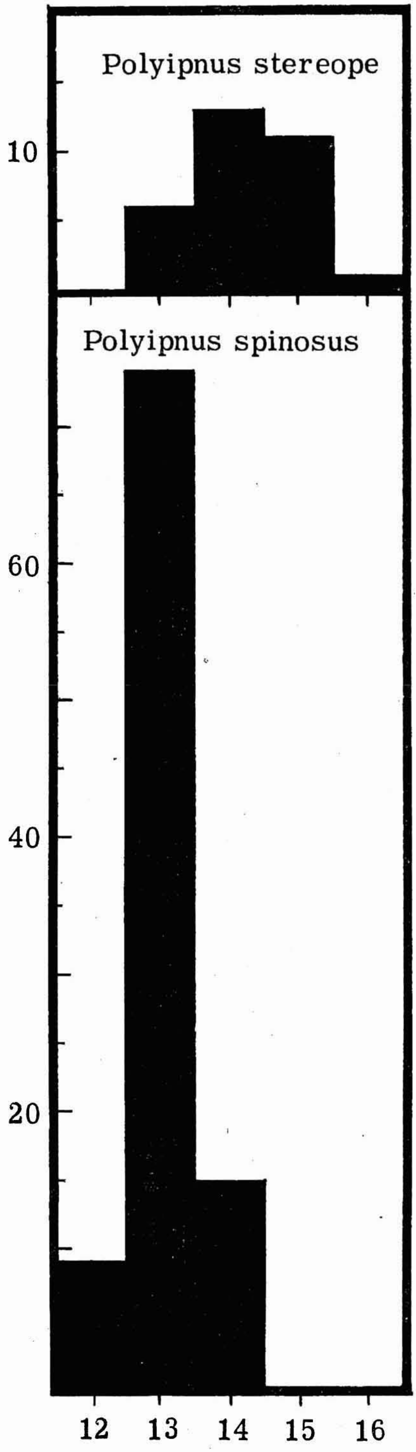

FIG. 7. Frequency of pectoral fin rays in *Polyipnus spinosus* and *P. stereope*.

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TABLE 3

"SLOPE AND POSITIONAL DIFFERENCES" BETWEEN TWO ALLOMETRIC LINES OF DEPTH AT END OF DORSAL–BODY LENGTH RELATIONSHIP

RESIDUE FORM	SUM OF SQUARES	(d.f.)	(S.S./d.f.)
Separate lines	0.06835	126	0.000542
Slope differences	0.00261	1	0.002610
Parallel lines	0.07096	127	$F_0=4.817^{*}$
Parallel lines	0.07096	127	0.000559
Positional differences	0.19794	1	0.197940
Single line	0.26890	128	$F_0=354.097^{**}$

TABLE 4

"SLOPE AND POSITIONAL DIFFERENCES" BETWEEN TWO ALLOMETRIC LINES OF DEPTH OF CAUDAL PEDUNCLE–BODY LENGTH RELATIONSHIP

RESIDUE FORM	SUM OF SQUARES	(d.f.)	(S.S./d.f.)
Separate lines	0.06968	126	0.000553
Slope differences	0.00448	1	0.004480
Parallel lines	0.07416	127	$F_0=8.101^{**}$
Parallel lines	0.07416	127	0.000584
Positional differences	0.32115	1	0.321150
Single line	0.39531	128	$F_0=549.932^{**}$

TABLE 5

"SLOPE AND POSITIONAL DIFFERENCES" BETWEEN TWO ALLOMETRIC LINES OF LENGTH OF POSTTEMPORAL PROCESS–BODY LENGTH RELATIONSHIP

RESIDUE FORM	SUM OF SQUARES	(d.f.)	(S.S./d.f.)
Separate lines	0.04707	126	0.000374
Slope differences	0.00000	1	0.000000
Parallel lines	0.04707	127	$F_0=0.000$
Parallel lines	0.04707	127	0.000371
Positional differences	0.10539	1	0.105390
Single line	0.15246	128	$F_0=284.070^{**}$

TABLE 6

SUMMARY OF "SLOPE AND POSITIONAL DIFFERENCES" BETWEEN TWO ALLOMETRIC LINES OF FOUR BODY PARTS TO BODY LENGTH

BODY PART	SLOPE DIFFERENCES	POSITIONAL DIFFERENCES
(a) Depth at origin of dorsal	–	**
(b) Depth at end of dorsal	*	**
(c) Depth of caudal peduncle	**	**
(d) Length of posttemporal process	–	**

**, significant (level of significance 1%)
*, significant (level of significance 5%)
-, insignificant

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